Q1(b) **Maximum mark: 3**

Response A **Marks**

$$V_h = 8 + 4t^2 - \frac{2}{3}t^3$$

$$\int 8t + \frac{4}{3}t^3 - \frac{1}{6}t^4$$

$$S_h = 8\times4 + \frac{4}{3}\times4^3 - \frac{1}{6}\times4^4$$

$$S_h = 74.66$$

$$= 74.7\ m$$

Q2(a)(i) **Maximum mark: 3**

Response A **Marks**

$v = r\omega$

$v = 0.35 \times 6.7$

$v = 2.3 \text{ rad s}^{-1}$

Response B

$v = \omega r$

$6.7 = \omega \times 0.35$

$\omega = 19.14 \text{ rads}^{-1}$

Response C

$V = \omega R$

$6.7 = \omega \times .35$

$\omega = 19 \text{ RAD s}^{-1}$

Q2(a)(ii) Maximum mark: 4

Response A **Marks**

$S = \omega_0 t + \frac{1}{2}\alpha t^2$

$= 19 \times 5.5 + \frac{1}{2} \times -2.4 \times 5.5^2$

$= 68$ RAD

$= 11$ REV

Response B

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$\theta = 19 \times 5.5 - 0.5 \times 2.4 \times 30.25$

$\theta = 68$ rotations

$\theta = 10.82$ revolutions

Response C

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

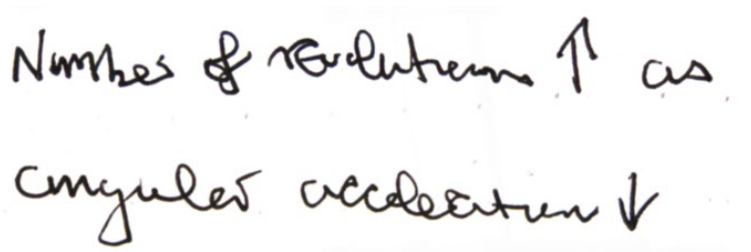
$\theta = 5.5 \times 19 + \frac{1}{2} \times -2.4 \times 5.5$

$\theta = 68.2$ rad

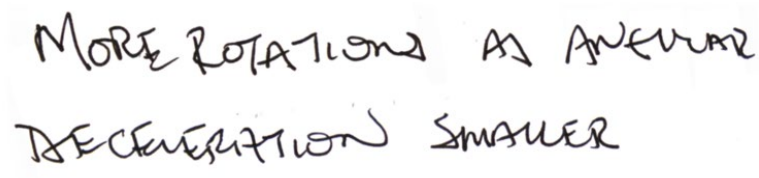
$\theta = \frac{68.2}{2\pi} = 10.9$ rev

Q2(a)(iii) **Maximum mark: 2**

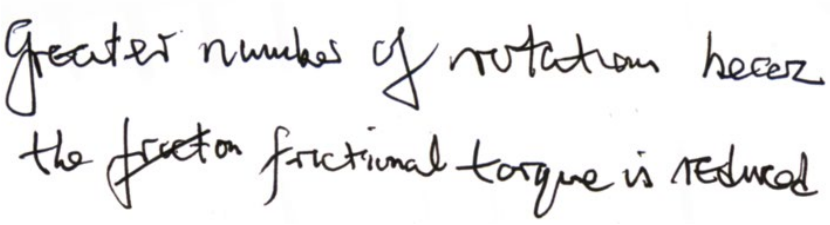
Response A **Marks**



Response B



Response C



Q2(b) **Maximum mark: 2**

Response A **Marks**

B

the ~~closer~~ further from the axis the greater the torque.

Response B

POSITION D as it is a greater distance from the axle of the wheel

Response C

$T = Fr$, due to Torque being directly proportional to the distance from the centre of a circle, position D would allow the greatest frictional Torque.

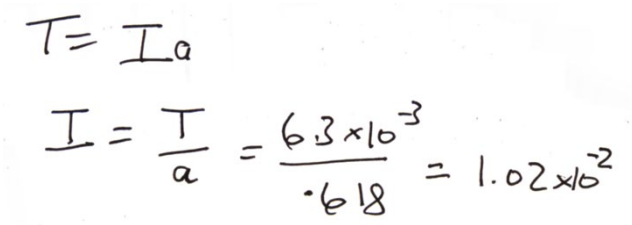
Response D

D

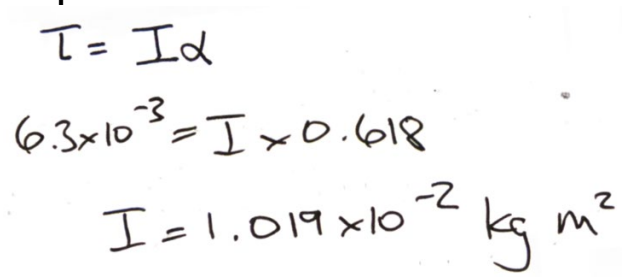
D is furthest from the centre of the wheel

Q3(a) **Maximum mark: 2**

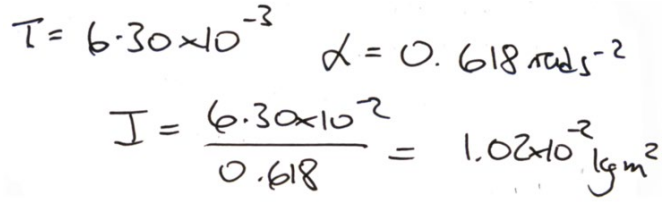
Response A **Marks**



Response B



Response C



Q3(b)(iii) Maximum mark: 2

Response A **Marks**

less than as 5.74 because the mass of the cube is greater

Response B

SAY I_{WBS} NOW 5×10^{-3} kg m^2

$1.02 \times 10^{-2} \times 7.5 = (1.02 \times 10^{-2} + 5 \times 10^{-2}) \times \omega_2$

$\omega_2 = 5.2$

SO ANGULAR VELOCITY LESS.

Response C

angular velocity NOW less because $I = mr^2$ SO I greater since mass greater.

Q4(a)(i) **Maximum mark: 1**

Response A **Marks**

THE FORCE A PLANET OR STAR EXERTS ON A MASS OF 1kg

Response B

The number of Newtons of force exerted on every kilogram of mass

Response C

The force of gravity acting on a kilogram of mass.

Q4(b) **Maximum mark: 2**

Response A **Marks**

RUNS FASTER AS A SMALLER FORCE OF GRAVITY ACTS ON IT THAN THE CLOCK ON EARTH

Response B

Faster, because gravity is less than on Earth.

Q4(c) **Maximum mark: 4**

Response A **Marks**

$v = \sqrt{2GM/r}$

$v = \sqrt{\left(\frac{2 \times 6.67 \times 10^{-11} \times 2 \times 10^{30}}{49.8 \times 1.5 \times 10^{11}}\right)}$

$v = 5.98 \times 10^{3}\ m s^{-1}$

Response B

$v = \sqrt{\frac{2GM}{r}}$

$r = 7.4 \times 10^{12}\ m$

$v = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 2 \times 10^{30}}{7.4 \times 10^{12}}}$

$v = 6.0 \times 10^{3}\ m s^{-1}$

Response C

$v = \sqrt{\frac{2GM}{r}} = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 2 \times 10^{30}}{7.5 \times 10^{12}}}$

$= 5.96 \times 10^{3}\ m s^{-1}$

Q6(b)(i) Maximum mark: 3

Response A

Marks

$L = 4\pi r^2 \sigma T^4$

$= 4\pi \times (8.35\times10^8)^2 \times 5.67\times10^{-8} \times (6070)^4$

$= 6.7\times10^{26}$ W

Response B

$L = 4\pi r^2 \sigma T^4$

$L = 4\times\pi\times 8.35\times10^8 \times 5.7\times10^{-8} \times (6070)^4$

$L = 6.78\times10^{26}$ W

Q6(c)(i) **Maximum mark: 4**

Response A **Marks**

$$\omega = \frac{2\pi}{T}$$

$$\omega = \frac{2\pi}{5040}$$

$$\omega = 1.24 \times 10^{-4} \text{ rads}^{-1}$$

Response B

$$3.5 \text{ days} = 3.5 \times 24 \times 60 \times 60$$

$$= 3 \times 10^{5} \text{ s}$$

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{3 \times 10^{5}} = 2.09 \times 10^{-4}$$

Q7(b)(i) Maximum mark: 2

Response A **Marks**

$$mvr = \frac{nh}{2\pi}$$

$$9.11\times10^{-31} \times v \times 2.12\times10^{-10} = \frac{2\times6.63\times10^{-34}}{2\pi}$$

$$v = 1.9\times10^{6}\ ms^{-1}$$

Response B

$$mvr = \frac{2h}{2\pi}$$

$$9.11\times10^{-31} \times v \times 2.12\times10^{-10} = \frac{6.63\times10^{-34}}{\pi}$$

$$v = 1.09\times10^{6}\ ms^{-1}$$

Response C

$$mvr = \frac{nh}{2\pi}$$

$$9.11\times10^{-31} \times v \times 2.12\times10^{-10} = \frac{2h}{2\pi}$$

$$v = 1.09\times10^{6}\ ms^{-1}$$

Q7(c) **Maximum mark: 2**

Response A **Marks**

$$\frac{1}{410\times10^{-9}} = R\times1^2\left(\frac{1}{2^2}-\frac{1}{6^2}\right)$$

$$R = 1.10\times10^{7}$$

Response B

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2}-\frac{1}{n_f^2}\right)$$

$$\frac{1}{410\times10^{-9}} = R\times1^2\times\left(\frac{1}{6^2}-\frac{1}{2^2}\right)$$

$$R = 1.098\times10^{7}\ m^{-1}$$

Q8(a) **Maximum mark: 1**

Response A **Marks**

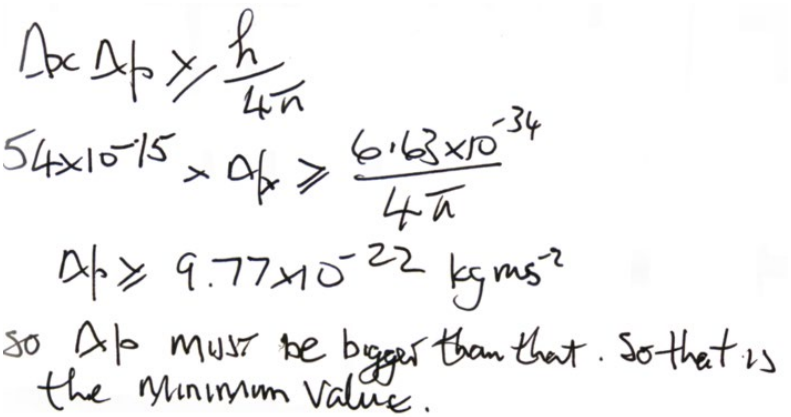
When the wave representing a particle extends through a potential barrier.

Response B

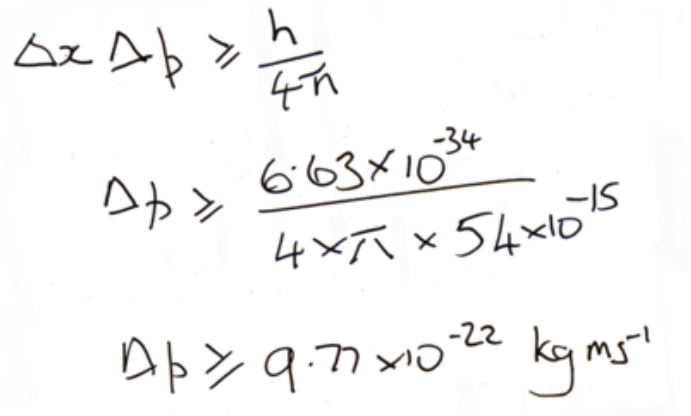
$\Delta E \Delta t \geq \frac{h}{4\pi}$ so IF Δt is small, ΔE WILL BE LARGE, LARGE ENOUGH TO GET THROUGH A POTENTIAL BARRIER

Q8(b) **Maximum mark: 3**

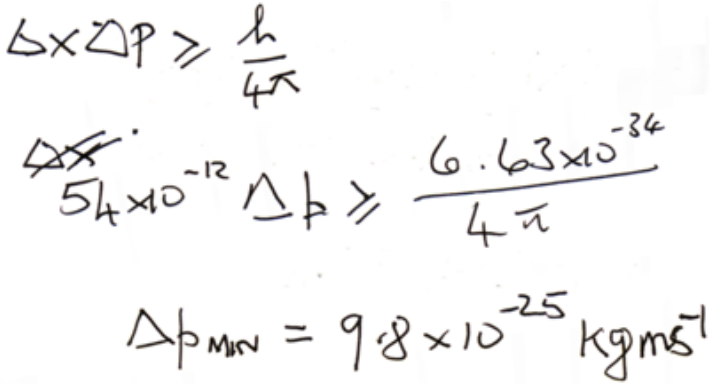
Response A **Marks**



Response B



Response C



Q8(c)(ii) Maximum mark: 2

Response A **Marks**

$$r = \frac{qQ}{2\pi\varepsilon_0 m v^2}$$

$$= \frac{3.2\times10^{-19}\times4.64\times10^{-18}}{2\times\pi\times\varepsilon_0\times6.654\times10^{-27}\times(2.1\times10^7)^2}$$

$$= 9.12\times10^{-15}\ m$$

Response B

$$r = \frac{9\times10^9\times3.2\times10^{-19}\times4.64\times10^{-18}}{6.654\times10^{-27}\times(2.1\times10^7)^2}$$

$$= 4.56\times10^{-15}\ m$$

Response C

$$M_\alpha = 2\times1.673\times10^{-27} + 2\times1.675\times10^{-27}$$

$$= 6.696\times10^{-27}\ kg$$

$$r = \frac{(2\times1.6\times10^{-19})\times(29\times1.6\times10^{-19})}{2\times\pi\times8.85\times10^{-12}\times6.696\times10^{-27}\times(2.1\times10^7)^2}$$

$$r = 9\times10^{-15}\ m$$

Q9(a) **Maximum mark: 1**

Response A **Marks**

THE FORCE ON A BODY IS PROPORTIONAL TO ITS DISPLACEMENT

Response B

$F = -Kx$

Response C

Simple harmonic motion is the restoring force of an object is directly proportional to and in opposition to the displacement from its Equilibrium position.

Response D

A system in which the acceleration is always equivalent to, and in the opposite direction of the displacement

Q9(c)(i) **Maximum mark: 3**

Response A **Marks**

$-ky = -m\omega^2 y$

$-1.5\times10^2 = -77\times\omega^2$

$\omega = 1.4 \text{ rad s}^{-1}$

Response B

$F = -ky \quad F = -m\omega^2 y$

$k = m\omega^2$

$150 = 77\times\omega^2$

$\omega = 1.396 \text{ rads s}^{-1}$

Q9(d) **Maximum mark: 2**

Response A **Marks**

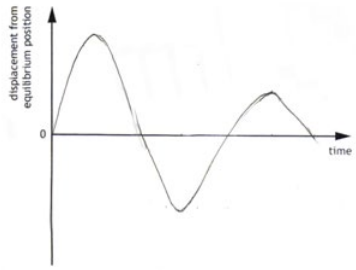


Figure 9B

Response B

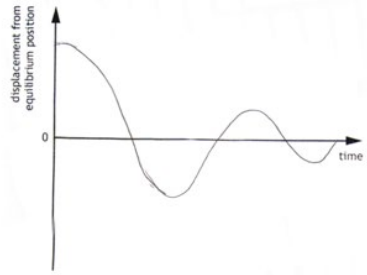


Figure 9B

Response C

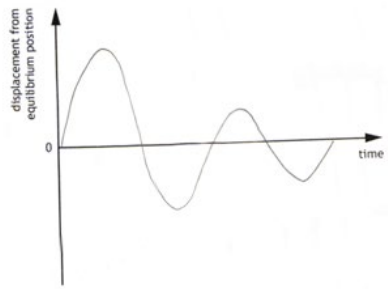


Figure 9B

Response D

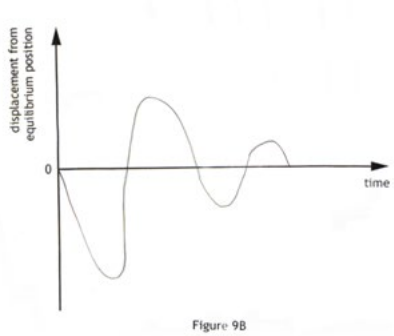
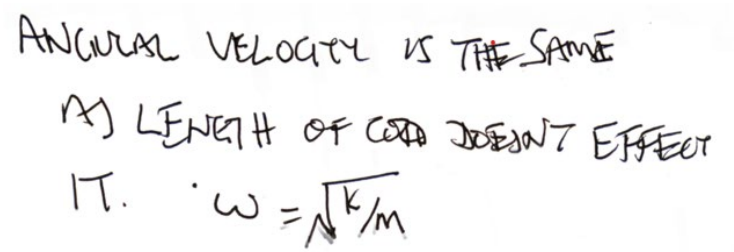


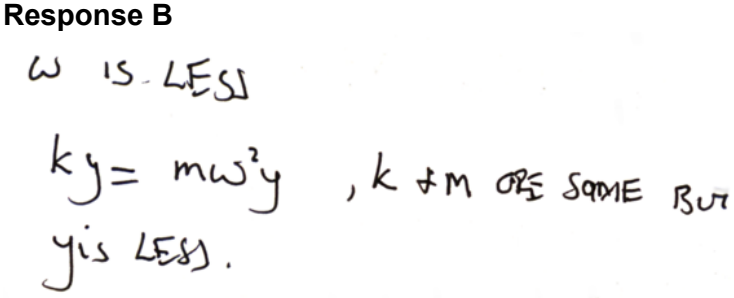
Figure 9B

Q9(e) **Maximum mark: 2**

Response A **Marks**



Response B



Q10(a) **Maximum mark: 1**

Response A **Marks**

The rays reflecting from the glass interfere destructively.

Response B

No light gets refleted because it all goes into the glass.

Q10(d)(ii) Maximum mark: 3

Response A **Marks**

$$E A^2 = K$$

$$A^2 = \frac{90 \times (1.6 \times 10^5)^2}{100}$$

$$A = 1520 \text{ V/m}$$

Response B

$$E = KA^2$$

$$A = \frac{90 \times [1.6 \times 10^5]^2}{100}$$

$$A = 1.5 \times 10^2 \text{ Vm}^{-1}$$

Response C

$$A = 1500$$

Q11(b)(i) Maximum mark: 1

Response A

Marks

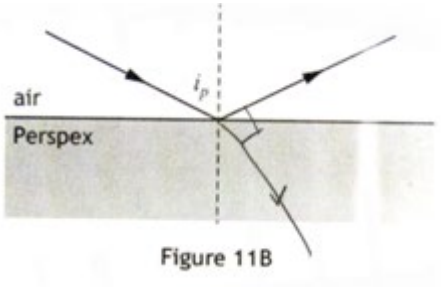


Figure 11B

Response B

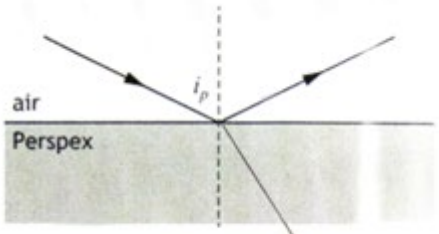


Figure 11B

Response C

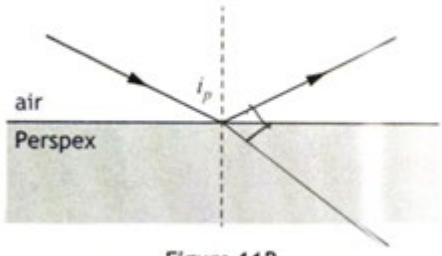


Figure 11B

Q11(c) **Maximum mark: 2**

Response A **Marks**

BRIGHT AT A

THEN DARK THEN BRIGHT

AGAIN AT B

Q13(b) **Maximum mark: 3**

Response A **Marks**

$$V = \frac{Q}{4\pi\varepsilon_0 r^2}$$

$$= \frac{2.56 \times 10^{-9}}{4\pi\varepsilon_0 \times 0.4}$$

$$= 58\ V$$

Response B

$$V = E_{-}d$$

$$= 144 \times 0.4$$

$$= 58\ V$$

Q13(c) **Maximum mark: 4**

Response A **Marks**

$W = PV$

$W_y = 2 \times 10^{12} \times 57.5$

$W_x = 2 \times 10^{-2} \times 19.2$

$W = 2 \times 10^{-12} \times (19.2 - 57.5)$

$W = 76.6 \times 10^{-12}$ J

Q14(c) **Maximum mark: 1**

Response A **Marks**

Because the proton has to travel in one direction and then in the other direction like an ac current.

Response B

An AC supply must be used to make the protons change direction.

Response C

To allow the photon to travel between the Ds in an alternating direction → ←

Q15(a)(i) Maximum mark: 1

Response A

Marks

When the switch is closed the magnetic field round the inductor is Zero.

The magnetic field gets stronger and as it changes and grows you get a back EMF in the inductor.

Q15(a)(ii) **Maximum mark: 4**

Response A **Marks**

$E = -L\,dI/dt$

$4 = -L \times 1.73$

$L = 2.31\ H$

Response B

$E = L\dfrac{dI}{dt}$

$4 = L \times 1.73$

$L = 2.3\ H$

Response C

$\mathcal{E} = -L\,dI/dt$

$4 = L \times 1.73$

$L = 2.3\ H$

Q15(b) **Maximum mark: 2**

Response A **Marks**

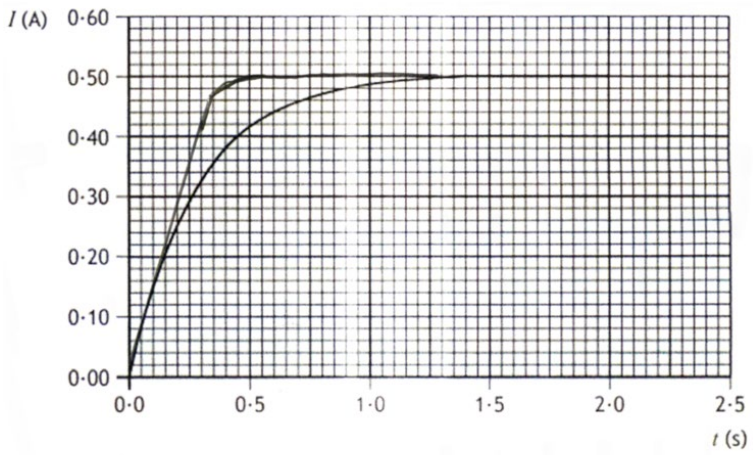


Figure 15C

Response B

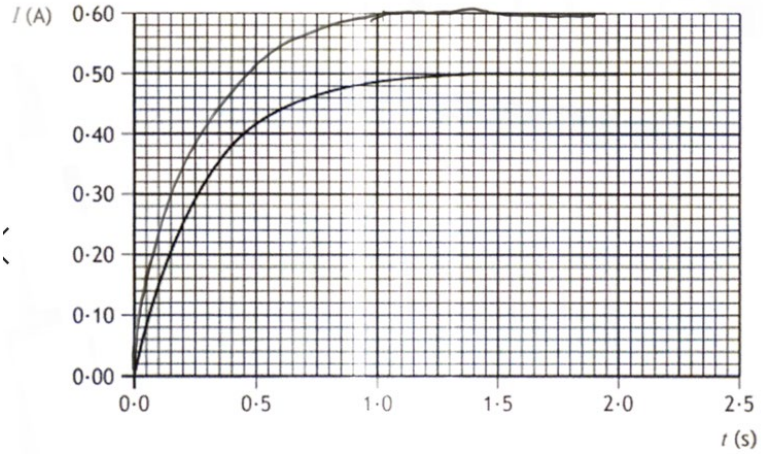


Figure 15C

Response C

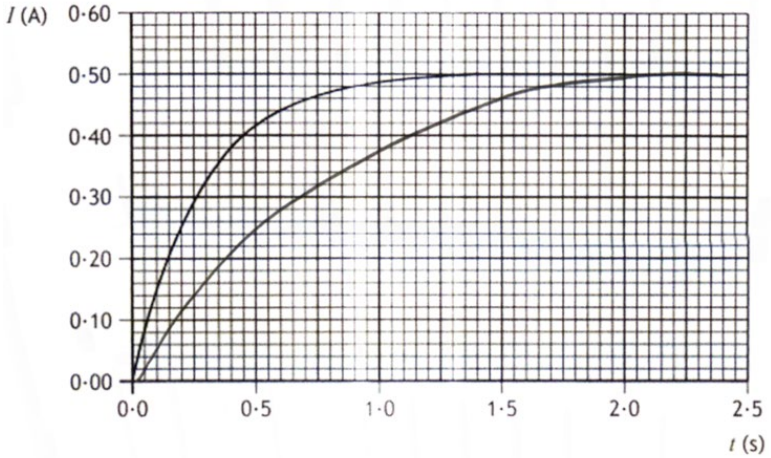


Figure 15C